Step 2: **Watershed Assessment**

Introduction

The Watershed Assessment step provides an opportunity to collect information about key ecosystem processes that can be used to interpret watershed conditions and help guide restoration efforts. The Watershed Assessment can be used for some of the following purposes:

- To document current and historical watershed conditions.
- To identify important gaps in knowledge.
- To analyze the limiting factors most affecting aquatic species.
- To conduct pilot projects for monitoring and restoration.
- To establish watershed-specific standards for TMDLs.

The Watershed Assessment relies on an interdisciplinary, science-based approach to gather information about ecosystem processes, resource conditions, and historical changes. Changes in resource conditions can be due to specific practices and events or can be a result of the cumulative effects of management practices throughout the watershed. Various aspects of the ecosystem are evaluated using a series of technical modules that provide guidance on analyzing watershed conditions (Box 1). Each technical module contains a description of methods and tools that can be customized to address the watershed issues and project goals identified in Scoping.

Box 1. Technical modules

Resource modules identify important resources and determine resource sensitivities to changes in environmental conditions:

- Community Resources
- Aquatic Life
- Water Quality
- Historical Conditions

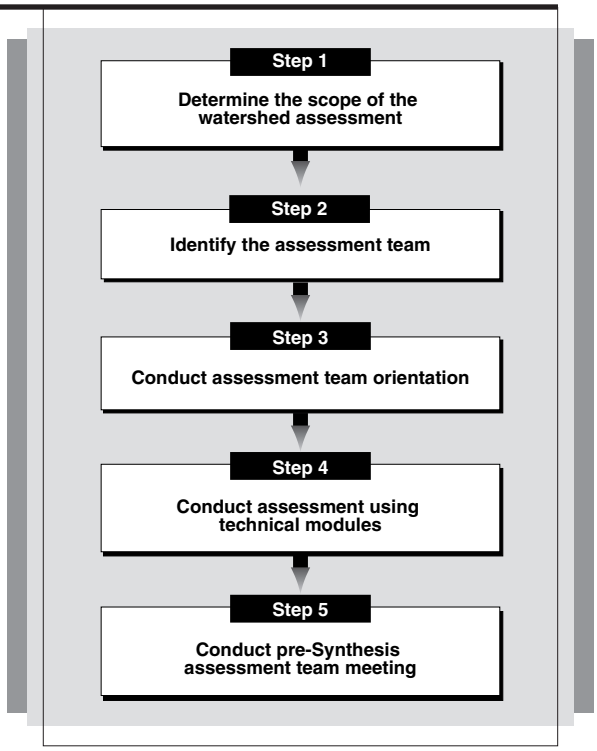
Process modules identify impacts caused by land uses or management practices:

- Hydrology
- Channel
- Erosion
- Vegetation

Watershed Assessment Process

Step Chart

Procedure



The objectives of the Watershed Assessment step are as follows:

- To define the type of technical analyses necessary to meet WAM project goals.
- To conduct defensible, science-based assessment at a watershed scale.
- To promote interaction among scientific disciplines.
- To identify connections among ecosystem processes, resource conditions, and human activities.
- To effectively summarize watershed conditions, land management influences, and information gaps.

Step 1. Determine the scope of the watershed assessment

Representatives from the watershed group who participated in the Scoping process should review the key watershed issues and project goals with technical staff who will be working on the Watershed Assessment. This discussion will help to ensure that the Watershed Assessment will meet the proposed project goals (Box 2). The technical staff should discuss the following questions with the watershed group representatives:

- Which technical modules are needed to address the key watershed issues?
- Which critical questions need to be addressed by the Watershed Assessment?
- Where are Level 1 methods sufficient to meet project goals?

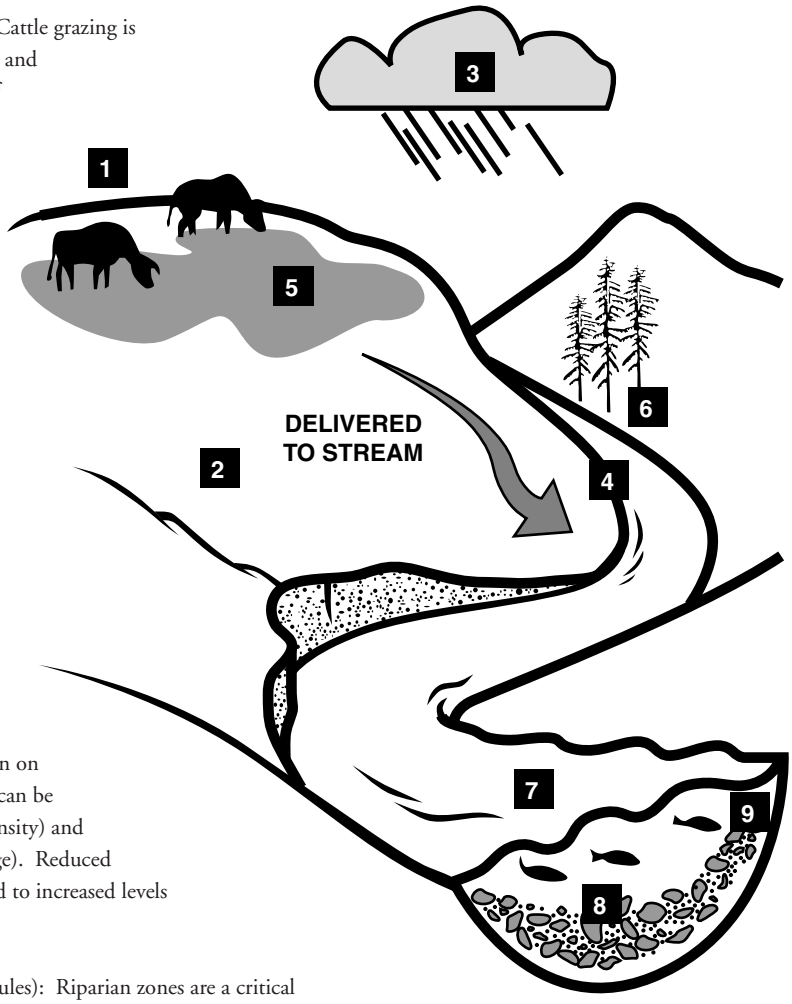
- Where are Level 2 methods necessary to meet project goals?
- How can existing studies or monitoring programs be integrated into the assessment?
- Are there sufficient resources available to conduct the assessment?
- What is a realistic schedule to complete the Watershed Assessment?
- What issues will require long-term data collection?

Box 2. Determining the appropriate scale for the Watershed Assessment

Defining the appropriate scale at which to assess watershed conditions can be a difficult issue. Land management practices may ultimately require site-specific evaluations, but conducting a technical assessment at this scale (typically a map or photo scale of 1:5,000 or smaller) is typically not feasible or desirable for an entire watershed given time and cost constraints. A larger scale, such as 1:50,000 or 1:100,000, may be more economical for addressing larger watershed issues such as regional planning but may lack the resolution necessary to recommend effective management and protection strategies within the watershed. Working at a scale of between 1:15,000 and 1:30,000 often provides cost-effective coverage and meaningful results that can be translated to site-specific projects. It should be emphasized, though, that even at this scale further work will inevitably be required to address problems at the site level. Whatever scale is used, map products should use a consistent scale to aid comparisons and allow for map overlays.

A useful tool for outlining the watershed issues and assessment needs is the creation of conceptual models. Figure 1 is a conceptual model illustrating components of the ecosystem that would need to be considered to evaluate impacts of cattle grazing. Each component of the model has an associated technical module to illustrate the potential scope of the assessment. Within the technical modules, critical questions are provided that can be used to further refine the scope of the assessment. Table 1 lists some common watershed issues and the modules and associated critical questions that address each issue.

Figure 1. Conceptual model for evaluating grazing impacts



1 **Cattle Grazing** (Community Resources module): Cattle grazing is one of many land use activities that can be culturally and economically important to local communities. The goal of watershed assessment is to ensure that these activities are conducted in a manner that can be sustained and that does not negatively impact the ecosystem.

2 **Physical Setting** (Erosion module): Identification of soils and parent material is essential to understanding erosion processes. Soils from various bedrock materials have different erosion potentials and support different types of vegetation.

3 **Climate** (Hydrology module): Consideration must be given to weather patterns and intensity of rainfall as factors driving erosion processes and affecting vegetation patterns.

4 **Topography** (Hydrology module): Slopes are a significant factor influencing erosion and accessibility for grazing. Slope aspect is also important in determining vegetation patterns.

5 **Vegetation Type** (Vegetation module): Information on current and historical conditions of vegetative cover can be critical to understanding system capacity (e.g., grazing intensity) and changes over time due to historical uses (e.g., reduced forage). Reduced vegetative cover or a change in species composition can lead to increased levels of soil erosion.

6 **Riparian Zones** (Vegetation and Aquatic Life modules): Riparian zones are a critical component of the watershed, providing habitat and ecological functions (e.g., sediment buffer strip, stream shading, and nutrient input to streams).

7 **Water Quality** (Water Quality module): Water quality conditions dictate the type and status of aquatic life. Sediment from elevated erosion levels can eliminate habitat, warm water to critical levels, and introduce other pollutants to the water column.

8 **Aquatic Life** (Aquatic Life module): Fish are often a key ecological, cultural, and economic resource. Aquatic species are also good indicators of watershed ecosystem health. Impacts throughout the watershed are reflected in aquatic habitat conditions.

9 **Stream Channel** (Channel module): The stream channel is a dynamic feature of the watershed with conditions that are defined by a combination of natural physical characteristics. Changes is sediment delivery can modify the composition of the stream bed, and loss of streamside vegetation can increase bank erosion.

Table 1. Examples of watershed issues and applicable modules and critical questions

Watershed Issues	Modules	Critical Questions*
Floods	Hydrology	**H1:** What is the seasonal variability in streamflow?
		H7: What are the potential land use impacts to hydrologic processes in the watershed?
	Channel	**C2:** How do climate and the frequency, magnitude, duration, and timing of floods affect channel conditions?
	Historical Conditions	**HC2:** What are the natural setting and disturbance regimes in the watershed?
Drinking water	Water Quality	**WQ2:** What water quality parameters do not meet the standard and for what time period?
	Hydrology	**H6:** For which beneficial uses is water primarily used in the watershed, and are surface water or groundwater withdrawals prominent?
	Community Resources	**CR4:** What processes or land use activities may be impacting community resources?
Floodplain/riparian conditions	Vegetation	**V4:** Does existing upland, riparian, or wetland vegetation differ substantially from historical conditions?
		V6: What are the important functions of riparian vegetation relative to watershed processes?
	Community Resources	**CR2:** Where are community resources located?
	Aquatic Life	**AL3:** What are the requirements of various life history stages of the aquatic species?
	Hydrology	**H5:** What water control structures are present in the watershed?
	Channel	**C5:** How and where have changes in riparian vegetation influenced channel conditions?
Algae blooms/ eutrophication	Water Quality	**WQ7:** What causes excessive algae growth or eutrophication?
	Aquatic Life	**AL5:** What connections can be made between past and present human activities and current habitat conditions?
Water temperature	Water Quality	**WQ2:** What water quality parameters do not meet the standard and for what time period?
	Aquatic Life	**AL3:** What are the requirements of various life history stages of the aquatic species?
	Vegetation	**V6:** What are the important functions of riparian vegetation relative to watershed processes?
Loss of rare native plant	Community Resources	**CR2:** Where are community resources located?
		CR4: What processes or land use activities may be impacting community resources?
	Vegetation	**V1:** What are the primary vegetation categories that exist in upland areas?
		V4: Does existing upland, riparian, or wetland vegetation differ substantially from historical conditions?

* **H1** = Module and critical question number

Modules: **AL** = Aquatic Life; **C** = Channel; **CR** = Community Resources; **E** = Erosion; **H** = Hydrology; **HC** = Historical Conditions; **V** = Vegetation; **WQ** = Water Quality

Table 1. (continued)

Watershed Issues	Modules	Critical Questions*
Wetlands functions and values	Hydrology	**H3:** What are the roles of groundwater and natural storage features in the watershed?
	Vegetation	**V3:** What are the primary vegetation categories that exist in wetland areas?
		V7: What are important functions of wetland vegetation relative to watershed processes?
	Aquatic Life	**A3:** What are the requirements of various life history stages of the aquatic species?
	Community Resources	**CR2:** Where are community resources located?
Bank erosion	Erosion	**E10:** How significant a sediment source is streambank erosion, and how have erosion rates changed over time?
	Hydrology	**H1:** What is the seasonal variability in streamflow?
	Vegetation	**V6:** What are the important functions of riparian vegetation relative to watershed processes?
	Channel	**C1:** How does the physical setting of the watershed influence channel morphology?
		C3: How and where has the behavior of the channel changed over time?
	Water Quality	**WQ9:** What conditions lead to excessive turbidity?
Fish consumption advisories	Aquatic Life	**A2:** What are the distribution, relative abundance, population status, and population trends of the aquatic species?
	Water Quality	**WQ5:** What causes fish consumption advisories?
Dams	Hydrology	**H5:** What water control structures are present in the watershed?
	Channel	**C10:** How does the presence and management of dams and levees affect channel conditions?
	Aquatic Life	**A5:** What connections can be made between past and present human activities and current habitat conditions?
	Historical Conditions	**HC3:** Where and when have landscape changes occurred in the watershed?
Threatened or endangered aquatic species	Aquatic Life	**A5:** What connections can be made between past and present human activities and current habitat conditions?
		A2: What are the distribution, relative abundance, population status, and population trends of the aquatic species?
	Channel	**C11:** What is the potential for change in channel conditions based on geomorphic characteristics?
	Erosion	**E12:** What are the primary sources of sediment delivery to waterbodies?
	Vegetation	**V6:** What are the important functions of riparian vegetation relative to watershed processes?
	Hydrology	**H6:** For which beneficial uses is water primarily used in the watershed, and are surface water or groundwater withdrawals prominent?

* **H1** = Module and critical question number

Modules: **A** = Aquatic Life; **C** = Channel; **CR** = Community Resources; **E** = Erosion; **H** = Hydrology; **HC** = Historical Conditions; **V** = Vegetation; **WQ** = Water Quality

Technical advisors may want to discuss hypotheses about watershed processes and resource impacts (Box 3). These hypotheses may also help further refine the scope and level of assessment necessary to meet project goals. Hypotheses related to issues identified in Figure 1 might include the following:

- Grazing on highly erodible soil contributes the majority of sediment to streams.
- Natural soil erosion causes high turbidity measurements.
- Grazing has altered vegetation communities and increased stream temperatures.
- Erosion from grazing is only a problem on steep slopes near streams.
- Floods are responsible for increased bank erosion.
- Grazing has significantly increased bank erosion and altered aquatic habitat.

If significant changes are proposed in the scope of the Watershed Assessment, it may be necessary to review the issues with all Scoping participants.

Box 3. Generating hypotheses

Generating hypotheses is a vital part of any scientific assessment. Hypotheses can help to determine the required scope of assessment and to focus data collection and analysis on specific objectives. A hypothesis is defined as an assumption that needs verification or proof. Hypotheses are clearly defined statements that can be evaluated during the Watershed Assessment. Data from the assessment can then be used to support or disprove the hypotheses. Often, further data collection and evaluation of competing hypotheses are necessary following the initial Watershed Assessment.

Using a hypothesis to guide the Watershed Assessment

Hypothesis:	Grazing has increased the amount of fine sediment on the streambed due to soil compaction and trampling of the streambank.
Level 1 Assessment:	The Erosion module identifies soil types that are most susceptible to disturbance from grazing. The Channel module maps bank disturbance from aerial photos. The Aquatic Life module analyzes stream survey data on the percentage of fine sediment in streams.
Level 2 Assessment:	The Erosion module quantifies erosion from different land management practices on various soil types. The Channel module quantifies bank erosion using field surveys and predicts sediment transport capacity of streams. The Aquatic Life module identifies potential fish spawning sites and measures fine sediment in the streambed.

Step 2. Identify the assessment team

The assessment team comprises environmental professionals who will use the technical modules or other methods to assess the watershed. For smaller assessments, the team may be composed of just a few local natural resource professionals, but for more complex issues, such as those addressed in a Level 2 assessment, many trained specialists and staff may be necessary (Table 2).

Table 2. Types of specialists to consult for a Level 2 assessment

Module	Profession
Community Resources	Historian, Anthropologist, or Archaeologist
Aquatic Life	Aquatic or Wildlife Biologist
Water Quality	Aquatic Ecologist, Environmental Engineer, Aquatic Biologist, Water Chemist, or Hydrologist
Historical Conditions	Historian or Librarian
Hydrology	Hydrologist or Environmental Engineer
Channel	Geomorphologist, Hydrologist, or Geologist
Erosion	Geologist, Geotechnical Specialist, Soil Scientist, or Geomorphologist
Vegetation	Ecologist or Botanist

Step 3. Conduct assessment team orientation

The composition of the assessment team will depend on the scope of the Watershed Assessment. A team leader is always important to coordinate logistics and to manage the assessment team. The team leader should make sure that assessment team members are acquainted with the watershed (e.g., by distributing maps and environmental reports) and with the WAM process (e.g., by providing copies of the WAM guide or a technical module). The team leader will also be responsible for producing a Watershed Assessment report. Table 3 provides a list of materials that are typically necessary for a Level 1 assessment.

The team leader should organize an initial meeting of the assessment team to do the following:

- Introduce team members.
- Distribute a team contact list.
- Clarify assessment objectives and hypotheses.

Table 3. Typical Level 1 assessment information needs

	Community Resources	Aquatic Life	Water Quality	Historical Conditions	Hydrology	Channel	Erosion	Vegetation
USGS topographic maps	●	●	●	●	●	●	●	●
Watershed base map	●	●	●	●	●	●	●	●
Land use map	●	●	●	●	●	●		●
Ecoregion summary			●	●	●			●
Geology maps					●	●	●	
Soils map			●		●	●	●	●
Slope class map (if GIS available)			●				●	
Aerial photos		●	●	●		●	●	●
Orthophotos					●		●	●
Fish habitat surveys		●				●		
Channel modification information		●		●	●	●		
Mean annual precipitation data					●			
USGS stream gage data		●			●	●		
Existing vegetation maps					●		●	●
National Wetland Inventory (NWI) maps		●						●
Federal Emergency Management Agency (FEMA) floodplain map			●			●		●
Water quality data and reports			●		●			
305 (b) list of state waterbodies			●					
303 (d) list of state waterbodies			●					
Endangered Species Act (ESA) listings or state endangered species		●						
National Pollutant Discharge Elimination System (NPDES) permit compliance data			●					

- Identify sources and availability of watershed data, aerial photos, maps, and environmental reports.
- Assign responsibilities for data collection and analysis (Box 4).
- Discuss assessment product requirements such as maps and reports.
- Establish assessment schedule.
- Note travel issues, such as gate keys, permission for access, and safety.
- Conduct a field tour of the watershed.

Box 4. Emphasizing an interdisciplinary approach

Many of the tasks conducted by individual analysts during the Watershed Assessment will generate useful information for other people on the assessment team. Sharing this information during the assessment will improve each module's evaluation and prepare the team for a productive Synthesis session. Within each technical module, arrow icons like the one shown below identify opportunities for sharing information with other module analysts. Data, preliminary conclusions, and other ideas can be shared using email, information-sharing software, fax, or telephone.

During the team orientation, it will be helpful to delineate sub-basins together so that areas of special interest can be analyzed at a similar scale. The assessment team should also discuss opportunities for joint data collection (e.g., stream surveys to collect data for the Water Quality, Aquatic Life, Channel, and Hydrology modules).

Step 4. Conduct assessment using technical modules

Each module analyst should review the appropriate technical module and customize the methodology as necessary to address the specific watershed issues and project goals identified during Scoping. The technical modules are located in the final sections of this guide.

The assessment team leader should periodically monitor the progress of the Watershed Assessment. The team leader may need to ensure that information sources are being shared and dialogue and interaction are occurring among team members. If GIS is being relied upon for analyses or map production, the team leader should coordinate regularly with the GIS specialist(s) to ensure a smooth and efficient transfer of information.

Step 5. Conduct pre-Synthesis assessment team meeting

A meeting of the assessment team prior to beginning the more formal Synthesis process is usually helpful to accomplish the following:

- Discuss interim findings and conclusions.
- Refine hypotheses based on shared information.
- Identify further assessment work needed.
- Review schedule and objectives.

Technical module analysts should be prepared with preliminary maps, tables, and graphs to summarize their findings. Preparing this material prior to Synthesis helps to organize the assessment results and identify gaps in information. Most of the material can also be used during Synthesis and in the Watershed Assessment report.